Financial openness and inflation targeting: an analysis for the unpleasant fiscal arithmetic

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Abstract
Emerging economies which have adopted inflation targeting and which combine low credibility, high public debt, and a high interest rate suffer from a typical problem. Increases in the interest rate to reduce departures of inflation from the target imply higher primary surplus for stabilizing public debt/GDP ratio. This tricky situation is known as "unpleasant fiscal arithmetic" (UFA). This article develops a theoretical model showing how an increase in financial openness and capital account liberalization can mitigate UFA. Furthermore, empirical evidence from the Brazilian case through OLS, GMM, and GMM system methods is offered. The findings denote that increases in capital mobility and financial openness work as a commitment technology which contribute to the success of the inflation targeting and thus reduce the risk of UFA occurs.

Key words: financial openness, capital account liberalization, unpleasant fiscal arithmetic, inflation targeting, credibility, output.

Resumo
As economias emergentes que adotaram o regime de metas para a inflação e que combinam baixa credibilidade, elevada dívida pública e uma alta taxa de juros sofrem de um problema típico. Aumentos na taxa de juros para conter a inflação implicam maior superávit primário para estabilizar a razão dívida pública/PIB. Essa situação delicada é conhecida como "desagradável aritmética fiscal" (DAF). Este artigo desenvolve um modelo teórico que mostra como um aumento da abertura financeira e da liberalização da conta de capitais pode atenuar a DAF. Além disso, são apresentadas evidências empíricas para o caso brasileiro por meio de modelos MQO e GMM. Os resultados indicam que o aumento da mobilidade de capitais e a maior abertura financeira funcionam como uma tecnologia de compromisso capaz de contribuir para o sucesso do regime de metas para a inflação e, dessa forma, reduzir o risco de a DAF ocorrer.

Palavras-chave: liberalização financeira, liberalização da conta de capitais, desagradável aritmética fiscal, metas para a inflação, credibilidade, produto.

Classificação JEL: E58, E63.

Área 4 - Economia do Setor Público

1. Introduction

Recently inflation targeting has been adopted by several emerging economies.[1] The main characteristic of the inflation targeting is that it works as a guide for the public's expectations. However, the monetary regime fails in the task of making the convergence between inflation expectations and the inflation target if there is no sufficient credibility. One of the main points for the success of inflation targeting is the absence of fiscal dominance. Furthermore, just as in the previous case, monetary dominance is not desirable.

One typical problem of emerging economies which have adopted inflation targeting is that a disinflationary monetary policy can cause a fiscal imbalance. The reason is that, under an inflation targeting regime, interest rate is the main instrument available for the central bank in managing the monetary policy. Moreover, in countries like Brazil, public debt is strongly indexed to the interest rate. Therefore, increases in interest rate in order to reach the inflation target imply increases in primary surplus for stabilizing public debt/GDP ratio. This tricky situation is known as "unpleasant fiscal arithmetic" (UFA) and it is necessary to find frameworks capable of mitigating it.

In the search for mechanisms capable of avoiding the inflation bias of discretionary monetary policy, financial openness and capital account liberalization are pointed to as a solution (Bartolini and Drazen, 1997; Gruben and McLeod, 2001; Gupta, 2008; Badinger, 2009; and Spiegel, 2009). The main idea is that a greater freedom for capital flow reduces the time inconsistency problem in monetary policy. The reason is that a reduction in capital controls increases the elasticity of substitution between the domestic and the foreign currency and thus demands a transparent and accountable behavior of the central bank. Hence, one consequence is that a low inflation policy by the central bank is more credible.

Therefore, it is possible to consider openness (financial and capital account liberalization) as a strategy for avoiding UFA. This article makes a contribution in this direction. A theoretical model is developed showing how an increase in openness contributes to the convergence between inflation and its target and thus to decrease the primary surplus. Furthermore, empirical evidence concerning UFA from the Brazilian case is offered. Besides Brazil being one of the most important emerging economies, the analysis for this country is suitable because it has several characteristics which are propitious for analyzing an environment with UFA and the effect caused by openness (inflation targeting, capital controls had been reduced, high interest rate, public debt is strongly indexed to the interest rate, and central bank credibility is still developing).

Besides this introduction, this article is organized as follows. The next section presents a small survey of the relation between capital mobility and its effects on inflation rate. Section 3 develops a theoretical model which considers how an increase in financial openness can mitigate UFA. Section 4 shows empirical evidence, based on the Brazilian case, through the application of ordinary least squares (OLS), generalized method of moments (GMM), and GMM system. The last section presents the conclusion.

2. Capital mobility and inflation

Rogoff (2003) shows that the market globalization has a double role: implies a decrease in the price of goods, and contributes to the settlement of lower inflation targets. Furthermore, the increase in the competitiveness increases price flexibility and thus weakens the impact of the monetary policy on the economy.

As observed by Obstfeld and Taylor (1998), when capital controls are eliminated, the monetary authority needs to choose between adopting a fixed exchange rate or independent monetary policy. The reason is that the combination of these elements is not feasible. According to Dornbusch (1998),

[1] See, for example, Brazil, Colombia, Czech Republic, Ghana, Guatemala, Hungary, Indonesia, Mexico, Peru, Philippines, Romania, Slovak Republic, South Africa, Thailand, and Turkey.

independently from the exchange rate regime, the capital account liberalization is a constraint on monetary policy. The main idea is that the economic agents understand the increase in the openness as an increase in the central bank's commitment to low and stable inflation.

As highlighted by Frankel (1999), a combination of administered exchange rate and independent monetary policy is feasible because there exists the option of an intermediate capital control (between total mobility or total control). Although there exists this possibility, Calvo and Reinhart (2002) pointed out that the fear of floating the exchange rate is due to the lack of the central bank credibility. This observation is important because in the case of low central bank credibility the impact of fluctuations of the exchange rate on the inflation and on the financial system is not negligible.

Focusing on the inflation, one of the main channels for the effect of the capital account liberalization is the money demand elasticity. When the access to the foreign currency increases, the possibility of substituting the domestic currency for another which is more reliable also increases. Therefore, greater capital mobility can penalize the central bank when it adopts an inflationary monetary policy. As observed by Romer (1993), countries with greater commercial openness have lower inflation. The main reason is that a non-expected inflationary policy causes currency devalution and thus the pass-through is greater in economies which are more open. As highlighted by Wagner (2001), an increase in the openness implies an increase in the cost of an inflationary policy due to the greater competition among the countries, which in turn implies a higher risk of financial capital loss. In the same direction Cooke (2010), through a general equilibrium model, strengthens this idea showing that openness in an economy avoids the use of an inflationary monetary policy.

A good example of the empirical analysis which indicates that an increase in the capital mobility is associated with a lower inflation is shown by Gruben and McLeod (2001). These authors, taking into account a cross section of 100 countries, found a strong negative relation between inflation and capital account liberalization. The central idea is that greater capital account liberalization restrains the inflationary monetary policy because it facilitates the exchanges of currencies and thus strengthens the central bank's commitment to low inflation. These results are also observed in another empirical analysis made by Gupta (2008) through the use of dynamic panel data model considering 163 countries and the period which spans from 1980 to 2003.

Although the above arguments indicate that greater capital account liberalization is good for a lower inflation, part of the empirical literature shows a doubt concerning the advantages of this strategy. Rodrik (1998), based on a sample of 100 countries for the period from 1975 to 1989, did not find evidence that capital account liberalization is associated with a fall in inflation. The main argument is that free capital mobility amplifies the exposure of the economy to the external shocks.

Loungani, Razin and Yuen (2001) conclude that the degree of capital mobility is relevant for the inflation-output trade-off. In particular, a fall in the output due to a fall in the inflation is lower in countries with some capital control. Chin and Ito (2002) found evidence that the majority of the emerging economies, which have lower capital controls, is more unstable and has lower economic growth. Daniels and VanHoose (2009) observed that although greater capital account liberalization contributes to a decrease in inflation, it implies an increase in the sacrifice ratio.

3. Openness and the convergence of inflation to the target

The main objective of this section is to show a theoretical model where the openness (financial and capital account liberalization) works as a commitment technology which contributes to the convergence between the inflation expectations and inflation target.[2] According to the literature on capital account liberalization, this strategy would be desirable because it avoids the problem of time inconsistency in the management of the monetary policy.[3]

Financial and capital account liberalization create a punishment for the monetary authority in the

[2] The model framework is inspired by King (1995) and Rogoff (2003).
[3] See, Bartolini and Drazen (1997), Gruben and McLeod (2001), and Gupta (2008).

case of an inflationary policy. The punishment occurs through the substitution of currencies implying a fall in the central bank's reserves (case of fixed exchange rate) or an increase in the inflation due to a currency devaluation (case of flexible exchange rate). Since the private capital flows depend on the inflation expectation, this channel implies that the openness reduces the central bank's inflationary bias.

A basic point for the success of inflation targeting is that the public believes that the inflation target will be reached. In the search for this objective, the main instrument for the central bank is the interest rate (Freedman and Ötker-Robe, 2010). However, the settlement of the interest rate may consider the impact on the dynamic of the public debt and the future performance of the economy. The use of a high interest rate (tight monetary policy) in an attempt to reach the inflation target demands a high primary surplus as a way to impede an explosive path for the public debt.

One critical element for the success of the inflation targeting is how the future inflation expectations are built. In particular, an increase in the public debt represents a potential risk of monetization and thus, the public expectations concerning the achievement of the inflation target are deteriorated.[4] Therefore, a tight fiscal policy which assures the fiscal equilibrium is a mechanism for avoiding inflationary pressure.

This model considers an inflation targeting environment. Hence, the main objective of the central bank is to reach the inflation target (π^*). Furthermore, the relation between households and firms is observed through the labor market. The households decide the labor supply based on the real wage. Therefore, inflation expectations (π_t^e) have a crucial role in this process. Moreover, the real wage is determinant of labor demand by firms. Hence, when the inflation (π_t) is different from the inflation expectations the consequence is a change in the output (y_t). In specific, when the inflation is greater than the inflation expectation ($\pi_t - \pi_t^e > 0$) the result is an output greater than that which corresponds to the flexible prices ($\bar{y}$). Consequently, the output (in logs) is given by

(1) $$y_t = \bar{y} + (\pi_t - \pi_t^e) - z_t \qquad z_t \sim N(0, \sigma^2),$$

where z_t is a random supply shock. The monetary authority defines the policy to be adopted in the period t after the public's inflation expectations in *t-1* and to observe the occurrence of any supply shock.

The central bank's loss function (equation 2) follows the standard in the literature, that is, it considers the departures of inflation from the target and of output from the socially optimal level. Thus,

(2) $$L_{CB_t} = (y_t - y^*)^2 + \chi(\pi_t - \pi^*)^2,$$

where χ is a positive constant and gives the relative weight which the central bank attributes to the inflation stabilization.

As a manner of considering the time inconsistency problem due to the presence of an inflationary bias in the model, the socially optimal output is greater than to the full employment. According to Kydland and Prescott (1977) and Barro and Gordon (1983), this hypothesis is a consequence of, for example, positive marginal taxation (the households do not receive all advantages from additional work) or imperfect competition (firms do not receive all advantages from additional output). Hence, $y^* - \bar{y} = k > 0$, where k is the central bank's inflationary bias.

Making the substitution of equation (1) into equation (2) for comprehending the inflation's effect on central bank's loss function, then

(3) $$L_{CB_t} = (\pi_t - \pi_t^e - k - z_t)^2 + \chi(\pi_t - \pi^*)^2.$$

Assuming that economic agents have rational expectations and know the central bank's loss function, the monetary authority's problem is to reach the inflation capable of minimizing its losses.

[4] This environment is more probable in emerging economies with a history of high inflation where the fear of a monetization is greater than in the case of developed countries.

Therefore, based on (3), the first order condition is

(4) $2(\pi_t - \pi_t^e - k - z_t) + 2\chi(\pi_t - \pi^*) = 0$, and thus,

(5) $$\pi_t = \frac{\pi_t^e + k + z_t + \chi\pi^*}{1+\chi}.$$

Therefore, the monetary authority's optimal inflation is a function of the expected inflation rate. Since that uncertainty is not considered in the model, the public perceives the inflation rate that will be implemented by the central bank. As a consequence, the inflation expectations built in the period *t-1* correspond to:

(6) $$\pi_t^e = E_{t-1}(\pi_t) = E_{t-1}\left(\frac{\pi_t^e + k + z_t + \chi\pi^*}{1+\chi}\right)$$, as $E_{t-1}(z_t) = 0$, expected inflation is

(7) $\pi_t^e = \pi^* + k/\chi$.

Hence, an increase in the gap between the socially optimal output and the equilibrium with flexible prices (*k*) implies an increase in the expected inflation rate. Due to the possibility of the central bank settling the interest rate after observing the public's inflation expectations, the ex-post optimal result is different from ex-ante and thus a dynamic inconsistency problem is created. In other words, if the central bank states a inflation target π^* and the public believes that this target will be reached, then $\pi_t^e = \pi^*$. However, after to know the public's expectations the monetary authority has an incentive to implement a greater inflation for achieving the optimal social output ($\pi > \pi^*$). Therefore, assuming rational expectations in the model, the public's expectations become $\pi_t^e > \pi^*$.

In the same way as above, a greater relative weight given by the monetary authority for the price stability over a greater output, the lower is the inflation expectation. In other words, as highlighted by Rogoff (1985) when the public perceives that the monetary policy is controlled by a conservative central banker the result is a lower inflation expectation. In brief, as private capital flows is associated with inflation expectations, it is expected that and an increase in the capital account liberalization decreases the central bank's inflation bias.

Taking into account the effect of the capital mobility on the central bank's loss function, equation (3) can be rewritten as

(8) $$L_{CB_t} = \left[\mu(\pi_t - \pi_t^e) - k - z_t\right]^2 + \chi(\pi_t - \pi^*)^2,$$

where μ is a positive constant and refers to the level of control on the capital account. The main idea is that the adoption of capital controls implies an increase in the asymmetric information between the central bank and the public. Hence, a market failure is created and the consequence is an increase in the central bank's inflationary bias. Therefore, the monetary authority's problem is:

(9) $\min_{\pi_t} L_{CB_t} = \left[\mu(\pi_t - \pi_t^e) - k - z_t\right]^2 + \chi(\pi_t - \pi^*)^2$, and thus, the first order condition implies that

(10) $2\left[\mu(\pi_t - \pi_t^e) - k - z_t\right]\mu + 2\chi(\pi_t - \pi^*) = 0$, then,

(11) $$\pi_t = \frac{\mu^2\pi_t^e + \mu k + \mu z_t + \chi\pi^*}{\mu^2 + \chi}.$$

The inflation expectations built in the period *t-1* are given by

(12) $$\pi_t^e = E_{t-1}(\pi_t) = E_{t-1}\left(\frac{\mu^2\pi_t^e + \mu k + \mu z_t + \chi\pi^*}{\mu^2 + \chi}\right)$$, and thus, inflation expected is

(13) $$\pi_t^e = \pi^* + \frac{\mu k}{\chi}.$$

The equation above shows an important implication. As a decrease in capital controls leads a lower μ, there is an increase in the central bank's commitment to achieve the inflation target, thus

contributing to a convergence between inflation expectation and the target. This result is in consonance with that presented by Tytell and Wei (2004) where a greater capital flow promotes a decrease in the inflation rate, even if the central bank is not fully committed to a low inflation policy ($k/\chi > 0$).

3.1. Openness and unpleasant fiscal arithmetic

The previous model is particularly relevant for analyzing a typical problem in emerging economies where the credibility is being built and there is the necessity of a tight monetary policy for assuring the convergence between the inflation rate and the target. In the last years the tripod of flexible exchange rate, inflation targeting and fiscal balance is the rule of thumb used by several emerging economies. In a general way, these economies search for a high level of credibility and are subject to the problem known as "unpleasant fiscal arithmetic" (UFA). In other words, when it is necessary to decrease inflation and there is not sufficient credibility, the consequence is an increase in the interest rate, which in turn creates an increase in public debt/GDP ratio. Hence, the lack of credibility implies a cost which is the primary surplus necessary to assure the fiscal balance (King, 1995).

Based on the previous model and arguments presented in King (1995) and Rogoff (2003) it is possible to see that the openness can avoid UFA because it works as a commitment technology which assures the convergence of inflation expectations to the target. Hence, assuming that the seigniorage is negligible and the public deficit is financed by issue of public bonds, the dynamic of public debt is

(14) $$\dot{D} = -PS_t + r_t^N D_t,$$

where D is the public debt; PS is the primary surplus; and r^N is the nominal interest rate.

Dividing both D and PS by the nominal GDP, d and ps respectively, equation (14) can be rewritten as

(15) $$\dot{d} = d_t(r_t^N - g_t - \pi_t) - ps_t,$$

where g is the economic growth rate and π is the inflation rate. The part $(r_t^N - g_t - \pi_t)$ gives the increase in the public debt due to the interest rate discounting the economic growth and the inflation rate.

Taking into account the real interest rate $(r_t = r_t^N - \pi_t^e)$, equation (15) corresponds to

(16) $$\dot{d} = d_t\left[(r_t - g_t) + (\pi_t^e - \pi_t)\right] - ps_t.$$

With the objective of observing the adoption of inflation targeting, this model considers an environment without full central bank credibility and the inflation target (π^*) is lower than the current inflation (π_0). As a consequence, the convergence of the inflation to the target takes place in a sluggish manner. The core of the idea is that low central bank credibility impedes that the inflation targeting works well as a guide for inflation expectations. Therefore a low convergence between inflation and the target is expected in this case. On the other hand, while the target is achieved over time the credibility (α_t) improves and thus the inflation expectations are close to the target, thus

(17) $$\pi_t^e = \pi^* - (\pi^* - \pi_0)e^{-\alpha_t}.$$

In regard to the fiscal balance, the primary surplus necessary to maintain the public debt/GDP ratio stable at its original level (d_0) is

(18) $$ps_t = (r_t - g_t)d_0 + (\pi_0 - \pi^*)d_0 e^{-\alpha_t},$$

where the first part of the right hand side of the equation above shows the effect caused by a real interest rate greater than the economic growth rate on the public debt. The second part of the right hand side of the equation apprehends the effect of the credibility on the public debt.

A lower credibility implies a greater impact of the deviations in inflation from its target,

(19) $$\lim_{\alpha_t \to 0}(\pi_0 - \pi^*)d_0 e^{-\alpha_t} = (\pi_0 - \pi^*)d_0.$$

Therefore the increase in the primary surplus necessary to maintain constant the public debt/GDP ratio under an environment without full credibility is

(20) $$\Delta ps_t = (\pi_0 - \pi^*) d_0 e^{-\alpha_t} .$$

Based on Rogoff (2003) and King (1995), capital mobility can works as an increase in the credibility for avoiding UFA. Hence, departures of inflation expectations from the target taking into account the relevance of the openness corresponds to

(21) $$\pi_t^e = \pi^* - \frac{\mu k}{\chi}(\pi^* - \pi_t) \text{ , or}$$

$$\pi_t^e = \pi^* - \frac{(\pi^* - \pi_t)}{\chi / \mu k}, \qquad \text{where } \pi_t = \pi_0 .$$

The intuition behind equation (21) is similar to that in equation (13), that is, openness contributes to the convergence between the inflation expectations and the inflation target. With the objective of observing the direct effect of capital controls (μ) on the public's inflation expectations and assuming the central bank's preference for inflation stabilization and inflation bias constant (χ=1 and k=1), equation (21) is simplified to

(22) $$\pi_t^e = \pi^* - \frac{(\pi^* - \pi_t)}{1 / \mu} .$$

Such as presented in equation (17), an increase in openness (β) over time provokes a quick adjustment of the inflation expectations to the target, and thus:

(23) $$\pi_t^e = \pi^* - (\pi^* - \pi_t) e^{-\beta_t} ,$$

where $\beta_t = 1/\mu_t$. Hence, the primary surplus to maintain the stability of the public debt considering the effect of capital account liberalization is

(24) $$ps_t = (r_t - g_t) d_0 + (\pi_t - \pi^*) d_0 e^{-\beta_t} .$$

The second part of the right hand side of the equation above indicates that an increase in the openness contributes to a lower primary surplus due to the divergence between inflation and the target. Hence, in the case of perfect capital mobility

(25) $$\lim_{\beta_t \to 0} (\pi_t - \pi^*) d_0 e^{-\beta_t} = 0 .$$

Contrary to this, when the capital account liberalization is near zero, whatever deviation of the inflation from the target provokes an increase in primary surplus, thus,

(26) $$\lim_{\beta_t \to 0} (\pi_t - \pi^*) d_0 e^{-\beta_t} = (\pi_t - \pi^*) d_0 .$$

Therefore, considering an environment with imperfect capital mobility, the increase in primary surplus which is necessary to maintain stable public debt/GDP is:

(27) $$\Delta ps_t = (\pi_t - \pi^*) d_0 e^{-\beta_t} .$$

The equation above shows that greater capital mobility attenuates the fiscal effort because it contributes to the convergence of the public's inflation expectations to the target. In brief, greater openness strengthens the central bank's commitment to achieve the inflation target and thus reduces UFA.

4. Empirical analysis

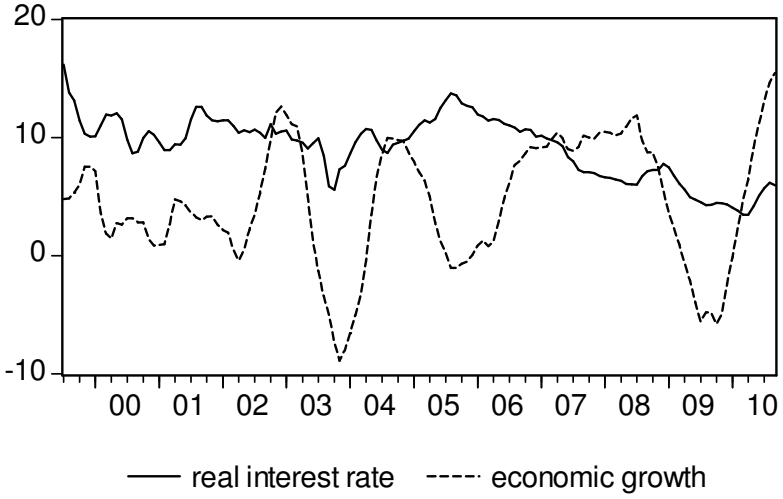
According to Sargent and Wallace (1981) the combination of two factors put in risk the control over inflation. The use of high interest rates, in an attempt to avoid an inflationary pressure, implies a negative impact on consumption and investment which in turn decreases the economic growth. Another concern is that high interest rates produce fiscal imbalances due to the increase in the public

debt. Those points are crucial for the analysis on UFA because it considers an environment where the central bank does not have full credibility, high interest rates are practiced after the adoption of inflation targeting, and the public debt is strongly indexed to the interest rate.

Brazil possesses the above-mentioned points and thus, indicates that an empirical analysis from this economy may observe if the openness attenuates the problem as indicated by the theoretical model. As can be seen through figure 1, over the period from 1999 to 2010 the real interest rate was greater than the economic growth rate a large part of the time. This observation suggests an environment of low central bank credibility (high interest rates for controlling inflation) with the necessity of primary surpluses for avoiding an increase in the public debt.

Figure 1

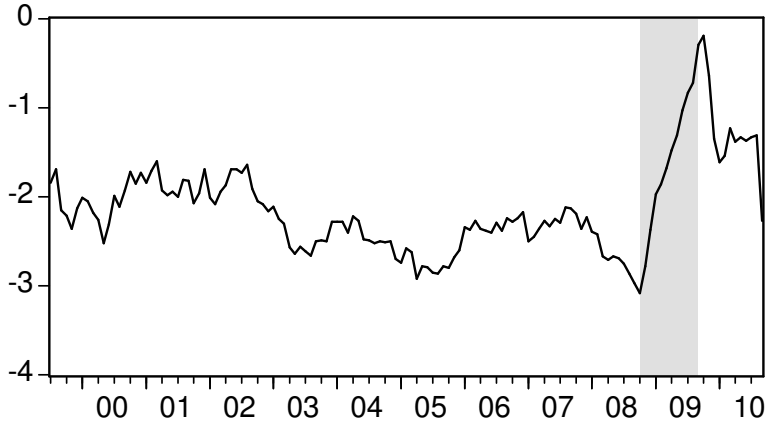
Real interest rate and economic growth rate (1999-2010)



The path of the primary surplus is another element that suggests that Brazil has an environment propitious for analyzing UFA. An increase in primary surplus (negative values) is observed especially after 2002 (see figure 2). The change in the trend observed at the end of 2008 and during 2009 (shaded area in the graph) is justified by the expansionist fiscal policy adopted in response to the fall in the economic growth caused by the subprime crisis.

Figure 2

Primary surplus/GDP (%) - 1999-2010



4.1. Openness under inflation targeting

Taking as reference the theoretical model, the openness can work as a tool for mitigating UFA. The Brazilian case is a good fit for an empirical analysis. In January of 1999, the adoption of the flexible exchange rate regime combined with a decrease in restrictions to foreign capital, and the openness of new foreign investment channels, stimulated the process of capital account liberalization in the country. Since 2000 the process remains through measures for reducing bureaucracy in the capital market.

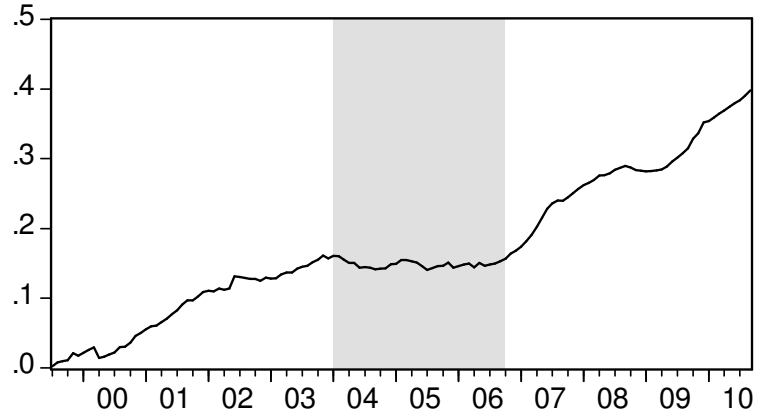
In this study, two indices of capital account mobility are considered. The first is the Financial Openness Index (FOI) which corresponds to a measurement of the capital flow movement month-to-month in the Brazilian economy over the period under analysis (July of 1999 to September of 2010). Hence,

(28) $$FOI = \sum \left(inflow - outflow \right) / GDP \, .$$

For building the index, data regarding financial and capital account of the Brazilian balance of payment made available by the Central Bank of Brazil (CBB) is used (see table A.1 - appendix). Figure 3 shows the evolution of the FOI accumulated and denotes that the periods which span from 2000 to 2003 and after 2006 are marked by a trend of liberalization. In contrast, the period from 2004 to 2006 shows stagnation in the movement (shaded area in the graph).

Figure 3

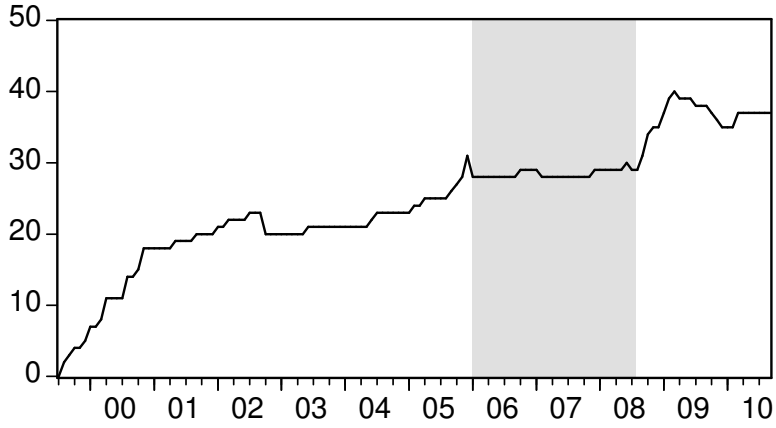
Financial openness index (1999-2010)



The second index considered in this analysis is a capital control index (CCI) based on monthly decrees (legislation of portfolio flow in the short run) for the period from July of 1999 to September of 2010.[5] The information on decrees is made available by CBB and the Brazilian Finance Ministry. Each decree is classified as: "+1" if it indicates liberalization; "-1" if it constrains the capital flow; and "0" if it only standardizes or communicates a fact without changes in the capital flow. Figure 4 shows the evolution of the accumulated CCI and indicates that the periods from 1999 to 2002 and after the subprime crisis the capital controls were reduce considerably, while between 2006 and 2008 there was relative stagnation (shaded area in the graph).

[5] A similar index was built by Cardoso and Goldfajn (1998).

Figure 4
Capital control index (1999-2010)



4.2. Data

With the intention of providing empirical evidence from the Brazilian case based on the theoretical model, the indicators (monthly frequency), made available by the CBB, used in this analysis for the period from July 1999 to September 2010 are:[6]

(i) Primary surplus *(PS)* – this indictor is the public borrowing requirements without devaluation (%GDP) – flows accumulated in 12 months – primary result (Federal Government and CBB). Primary surplus is the dependent variable in the model.

(ii) Deviation in inflation from the target $(\pi_t - \pi^*)$ – π^* is the weighted average of the target for the current year and the previous year;[7] and π_t is the Broad National Consumer Price Index (IPCA) accumulated in 12 months (official price index). It is expected that the lack of accomplishment of the inflation target implies an increase in the interest rate and thus, with some lag, an increase in the primary surplus for stabilizing the public debt/GDP ratio.

(iii) Difference between real interest rate and the growth economic rate (*R-G*) – the real interest rate is the Selic accumulated in the month in annual terms deflated by IPCA; the economic growth rate in the last 12 months is based on GDP accumulated in the last 12 months (at constant prices and seasonally adjusted). When the real interest rate is greater than the economic growth rate there is a negative impact on consumption and investment. Moreover, high interest rate provokes a rise in the public debt. Hence, it increases the risk of fiscal imbalance and thus primary surplus is necessary for the stabilization.

(iv) Public debt/GDP ratio (*D*) – is the net public debt (% GDP Federal Government and CBB). An increase in the public debt can be a result of an expansionist fiscal policy, and thus creates a pressure of demand which, in turn, implies a departure of inflation from the target.

(v) Interest rate (*IR*) – is the Selic accumulated in the month in annual terms. It is the main instrument for the central bank to reach the inflation target. Due to the relevance of the interest rate in the indexation of the Brazilian public debt, a rise in the interest rate for decreasing demand inflation increases the primary surplus for avoiding the risk of an unsustainable public debt path. Therefore, it is expected that an increase in the interest rate contributes to the convergence between inflation and the target.

[6] See table A.2 (appendix) with descriptive statistics of the series.
[7] For example, the target in June of 2002 is a result of (6*target 2002 + 6* target 2001).

(vi) Exchange rate (*EX*) – United States dollar (sale) – period average. An increase in the exchange rate causes an increase in the price of imported inputs and thus causes a rise in the inflation rate which, in turn, deviates from the target. Furthermore, it is important to highlight that in the period from January of 2000 to December of 2002 the relevance of the exchange rate in the indexation of the public debt was around 25%.

(vii) Financial openness index (*FOI*) – it is a result of equation (28). The main idea is that an increase in this index is associated with a decrease in the primary surplus for assuring stability in the public debt/GDP ratio. A greater capital flow implies an increase in the central bank's commitment to achieve the inflation target. As a consequence, a decrease in the interest rate is possible and thus a fall in the primary surplus for assuring constant public debt/GDP ratio.

(viii) Capital control index (*CCI*) – this series is made based on methodology presented in the previous section. The idea is similar to the case of the *FOI*. A decrease in capital control works as a commitment technology for the CBB to reach the inflation target.

4.3. Empirical evidence

Based on the theoretical model developed in section 3, an empirical analysis for observing UFA in the Brazilian economy is divided in three steps. A first step is the analysis concerning the effect of the deviation of inflation from the target on primary surplus. A second step presents evidence regarding financial openness (*FOI*) and capital controls (*CCI*) on the convergence between inflation and the target. A third step provides robustness to the found results by estimation of system of equations used in the previous steps.

Figure 5 shows the existence of a negative correlation between departure of inflation from the target and primary surplus. Moreover, in both cases of *FOI* and *CCI* there exists a negative correlation with deviation in inflation from its target. Those observations are in accordance with the theoretical view. In other words, an increase in the capital flow improves the central bank's commitment to reach the inflation target with a lower social cost, that is, less primary surplus which can be used for other ends instead of paying debt service.

Making use of the variables listed in the previous section, estimations of the primary surplus (based on equation 24) and of the convergence between inflation and its target (based on equation 27) consider three empirical models:[8]

$$(29)\quad PS_t = \delta_0 + \delta_1 (R-G)_{t-1} + \delta_2 (\pi_t - \pi^*)_{t-3} + \delta_3 D_t + \delta_4 dummy1 + \varepsilon_t, \qquad \varepsilon_t \sim N(0, \sigma^2);$$

$$(30)\quad (\pi_t - \pi^*)_t = \phi_0 + \phi_1 IR_{t-9} + \phi_2 EX_{t-3} + \phi_3 D_{t-6} + \phi_4 FOI_{t-1} + \phi_5 dummy1 + \phi_6 dummy2 + \varepsilon_t;$$

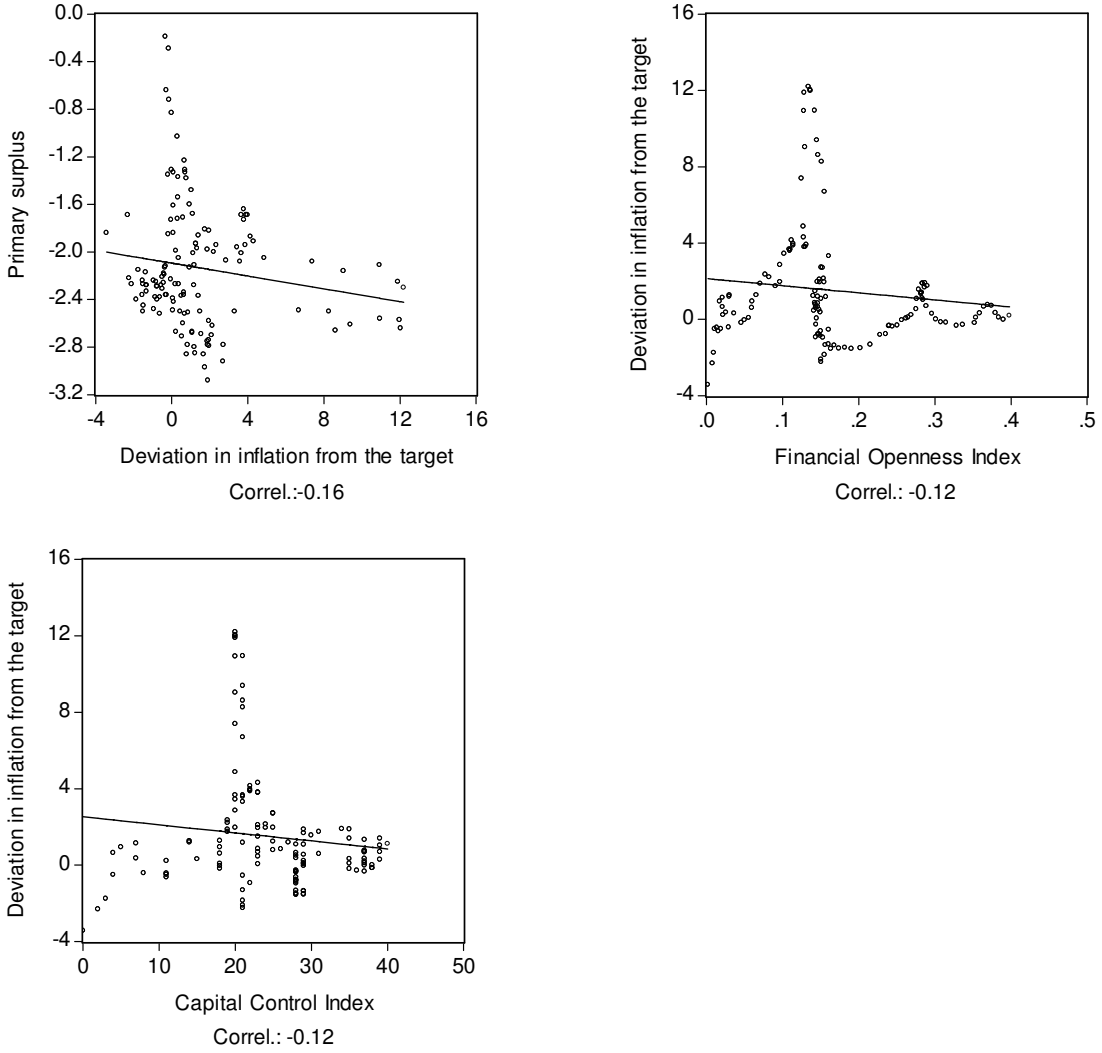
$$(31)\quad (\pi_t - \pi^*)_t = \tau_0 + \tau_1 IR_{t-9} + \tau_2 EX_{t-3} + \tau_3 D_{t-6} + \tau_4 CCI_{t-1} + \tau_5 dummy1 + \tau_6 dummy2 + \varepsilon_t;$$

where *dummy1* is the effect caused by the subprime crisis (assumes value "1" for the period from October of 2008 to September of 2009, and "0" otherwise); and *dummy2* is the confidence crisis in the Brazilian economy due to the presidential election in 2002 (assumes value "1" for the period from July of 2002 to June of 2003, and "0" otherwise).

[8] The number of lags on each variable in the empirical models is in agreement with the time that is necessary, through its transmission channels, for the variables used as regressors to cause an effect on the dependent variable.

Figure 5

Scatter diagrams (1999-2010)



Estimations of the equations above are made through ordinary least squares (OLS) and generalized method of moments (GMM). The reason for the application of the GMM is that it presents consistent estimators for the regressions even when problems as serial autocorrelation, heteroskedasticity, or nonlinearity, which are typical in macroeconomic time series, are observed (Hansen, 1982).

As a condition to predict the contemporaneous variables which are unavailable at time t, the use of instruments needs to be dated to the period t-1 or earlier (Wooldridge, 2001). In this sense, besides constant and lag of regressors, lag of output gap were considered as instruments.[9]

Before the use of time series it is necessary to check if the series have unit root. When the series are not stationary the possibility of the estimations being spurious is high. Therefore, with the objective of checking the presence or not of unit root in the series the unit-root test Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) were executed. The result denotes that the series are I(1) (see table A.3 - appendix).

The result from the unit root tests suggests that the use of the first difference of the series in the estimation of the equations is correct in order to avoid spurious regression. Nevertheless, long-term

[9] Output gap is the difference between GDP accumulated in the last 12 months (made available by the CBB with monthly frequency) and potential GDP (obtained by Hodrick-Prescott filter).

information contained in levels of time series will be lost after differencing (Chiarella and Gao, 2002). Therefore, it is necessary to check if a linear combination among series is stationary even if individually series are nonstationary. In other words, it is necessary to verify if the series are cointegrated because, in this case, to use series in level would imply reliable statistics.

Cointegration tests were performed taking into account the three equations in the empirical model and the results indicate that the series are cointegrated in each model (see tables A.4 and A.5 – appendix). As a consequence, there is a long-term equilibrium relationship among the variables under analysis and thus the equations can be estimated with the series in level without the problem of spuriousness.

Table 1 presents estimations based on OLS and GMM methods for equation (29). It is observed that the statistical significance and the sign of the coefficients are in agreement in both methods. Although the coefficient on the difference between real interest rate and the growth economic rate has a positive sign it is not statistically significant. In the same manner, the coefficient on the public debt/GDP ratio is positive without statistical significance. It is important to note that this observation is consistent with the theoretical model, where the public debt is a constant and thus it does not have a crucial role in the explanation of the primary surplus. Furthermore, as observed in the theoretical model, the main variable for explaining the primary surplus is the deviation of inflation from the target.

Table 1

Primary surplus (PS_t) – OLS and GMM estimations

variable	**OLS**	**GMM**
Constant	-3.3904***	-2.4225***
	(0.9422)	(0.8119)
	[-3.5983]	[-2.9837]
$(R - G)_{t-1}$	0.0109	0.0166
	(0.0152)	(0.0102)
	[0.7132]	[1.6329]
$(\pi - \pi^*)_{t-3}$	-0.0442**	-0.0288*
	(0.0197)	(0.0157)
	[-2.2475]	[-1.8393]
D_t	0.0381	0.0050
	(0.0290)	(0.0262)
	[1.3109]	[0.1905]
dummy1	0.9118***	0.7383**
	(0.3421)	(0.3457)
	[2.6654]	[2.1356]
Adj. R^2	0.27	0.24
F-Stat	12.94	
P(F-Stat)	(0.00)	
J-Stat		13.47
P(J-Stat)		(0.20)
S.E. reg.	0.45	0.47

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.10. Standard errors in parentheses and t-statistics in brackets.

As expected, the departure of inflation from the target matters in the behavior of the primary surplus. The coefficient on primary surplus is negative and statistically significant. One interpretation for this result is that there is no full central bank credibility over this period which, in turn, forces the CBB to increase the interest rate in order to reach the inflation target. The consequence of higher interest rate is an increase in the public debt service and a fall in the economic activity. Hence, for

avoiding the possibility of a fiscal imbalance, higher primary surplus is needed. Therefore, the empirical evidence is consonant with the theoretical view and thus strengthens the idea that it is necessary to find mechanisms which make the convergence of the inflation to the target as a way of mitigating UFA.

Table 2 shows the estimations for equations (30) and (31) using OLS and GMM methods. The results in both methods are in agreement. As expected from the theoretical view, the coefficient on the interest rate is negative and has statistical significance. Hence, an increase in the interest rate provokes a convergence between inflation and its target. In regard to the coefficient on the exchange rate, it is also compatible with theoretical predictions. The fact that it is positive and statistically significant indicates that the exchange rate channel is not negligible in the Brazilian economy. The relevance of the fiscal balance for the success of the inflation targeting is observed with the coefficient on the public debt. The positive sign of the coefficient and its statistical significance make clear that increases in the public debt/GDP ratio wreck the monetary system.

Table 2

Deviation in inflation from the target $(\pi - \pi^*)_t$ *– OLS and GMM estimations*

variable	**OLS**	**OLS**	**GMM**	**GMM**
Constant	-7.4202	4.3166	-4.6654	8.9473
	(6.0640)	(3.1533)	(4.4835)	(6.5654)
	[-1.2237]	[1.3689]	[-1.0406]	[1.3628]
IR_{t-9}	-0.3493**	-0.3395***	-0.4996***	-0.3963***
	(0.1413)	(0.0610)	(0.1300)	(0.1028)
	[-2.4722]	[-5.5614]	[-3.8433]	[-3.8551]
EX_{t-3}	0.1803**	0.2223***	0.1876**	0.2185**
	(0.0831)	(0.0540)	(0.0917)	(0.0981)
	[2.1705]	[4.1144]	[2.0457]	[2.2271]
D_{t-6}	0.4025**	0.3035***	0.4139**	0.2720**
	(0.1873)	(0.0897)	(0.1802)	(0.1332)
	[2.1492]	[3.3824]	[2.2967]	[2.0419]
FOI_{t-1}	-13.0851***		-17.984***	
	(4.3823)		(4.6102)	
	[-2.9859]		[-3.9010]	
CCI_{t-1}		-0.1919***		-0.2353***
		(0.0358)		(0.0593)
		[-5.3582]		[-3.9673]
dummy1	4.1057***	3.9679***	3.9915*	5.1403**
	(1.4938)	(0.6708)	(2.2256)	(2.0419)
	[2.7485]	[5.9149]	[1.7931]	[2.5175]
dummy2	1.8367**	2.2843***	2.2296*	3.1231**
	(0.7675)	(0.6848)	(1.2439)	(1.5322)
	[2.3932]	[3.3358]	[1.7925]	[2.0384]
Adj. R^2	0.68	0.70	0.66	0.68
F-Stat	45.39	49.95		
P(F-Stat)	(0.00)	(0.00)		
J-Stat			3.97	7.79
P(J-Stat)			(0.86)	(0.45)
Instrument rank			15	15

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, and (*) denotes 0.10. Standard errors in parentheses and t-statistics in brackets.

One important result from the estimations is the fact that the coefficients on both indices FOI and CCI are negative and statistically significant. Therefore, the theoretical argument that decreases in capital controls and increases in capital flow work as a commitment technology for the central bank

focusing on the inflation target is relevant. In other words, an increase in the openness contributes to reducing the divergence between inflation and an inflation target. As a consequence, the possibility of UFA under this environment decreases.

A manner of validating the equations and coefficients previously achieved is the estimation through system of equations (see Hallsten, 1999). For treating possible problems of endogeneity (in particular, in the relation between primary surplus and deviation in inflation from the target), the use of system of equations which applies GMM is adequate for estimating non-biased coefficients. Therefore, based on equations 29 to 31, two systems of equations are considered:

(32) *System 1:*
$$\begin{cases} PS_t = a_0 + a_1(R-G)_{t-1} + a_2(\pi_t - \pi^*)_{t-3} + a_3 D_t + a_4 dummy1 + \varepsilon_t \\ (\pi_t - \pi^*)_t = b_0 + b_1 IR_{t-9} + b_2 EX_{t-3} + b_3 D_{t-6} + b_4 FOI_{t-1} + b_5 dummy1 + b_6 dummy2 + \varepsilon_t \end{cases}$$

(33) *System 2:*
$$\begin{cases} PS_t = a_5 + a_6(R-G)_{t-1} + a_7(\pi_t - \pi^*)_{t-3} + a_8 D_t + a_9 dummy1 + \varepsilon_t \\ (\pi_t - \pi^*)_t = b_7 + b_8 IR_{t-9} + b_9 EX_{t-3} + b_{10} D_{t-6} + b_{11} CCI_{t-1} + b_{12} dummy1 + b_{13} dummy2 + \varepsilon_t \end{cases}$$

Table 3

PS and (π - π^*) - GMM system

System 1				***System 2***			
Variable	PS_t	**Variable**	$(\pi - \pi^*)_t$	**Variable**	PS_t	**Variable**	$(\pi - \pi^*)_t$
Constant	-2.4557***	*Constant*	-10.2533***	*Constant*	-2.7681***	*Constant*	7.8431*
	(0.7677)		(3.2466)		(0.7345)		(4.6836)
	[-3.1987]		[-3.1582]		[-3.7686]		[1.6746]
$(R - G)_{t-1}$	0.0171**	IR_{t-9}	-0.5343***	$(R - G)_{t-1}$	0.0179**	IR_{t-9}	-0.3267***
	(0.0080)		(0.1150)		(0.0082)		(0.0798)
	[2.1243]		[-4.6480]		[2.1850]		[-4.0937]
$(\pi - \pi^*)_{t-3}$	-0.0309**	EX_{t-3}	0.1883**	$(\pi - \pi^*)_{t-3}$	-0.0391***	EX_{t-3}	0.1332*
	(0.0144)		(0.0798)		(0.0142)		(0.0760)
	[-2.1485]		[2.3604]		[-2.7532]		[1.7516]
D_t	0.0065	D_{t-6}	0.6357***	D_t	0.0180	D_{t-6}	0.3830***
	(0.0246)		(0.1440)		(0.0235)		(0.1071)
	[0.2644]		[4.4147]		[0.7658]		[3.5766]
dummy1	0.7228**	FOI_{t-1}	-21.3835***	*dummy1*	0.8179**	CCI_{t-1}	-0.2611***
	(0.3311)		(3.6956)		(0.3148)		(0.0479)
	[2.1833]		[-5.7863]		[2.5976]		[-5.4503]
		dummy1	2.1437			*dummy1*	5.6652***
			(1.9410)				(1.6766)
			[1.1045]				[3.3790]
		dummy2	3.5419***			*dummy2*	4.4721***
			(1.0799)				(1.2455)
			[3.2797]				[3.5907]
Adj. R^2	0.25	Adj. R^2	0.64	Adj. R^2	0.25	Adj. R^2	0.66
J-statistic		0.14 p > 0.50		J-statistic		0.15 p > 0.40	

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, (*) denotes 0.1. Standard errors in parentheses and t-statistics in brackets.

Table 3 shows the estimations for both systems above.[10] The results indicate that all coefficients are in accordance with the theoretical view and, with the exception of the coefficient on public debt in the case where the primary surplus is the dependent variable, are statistically significant. Furthermore, the coefficients in the systems are close to those observed in the individual estimations. In addition, the fact that the estimation through the systems considerably increased the accuracy of the coefficients in the models (the standard errors are smaller) cannot be neglected. Therefore, once again empirical evidence shows that the openness is a useful tool for increasing the convergence between inflation and its target and thus reduces the risk of UFA occurring.

5. Concluding remarks

The theoretical model developed in this article shows that greater capital mobility attenuates the fiscal strength to assure that the central bank will reach the inflation target. Greater openness implies greater public confidence regarding central bank accountability because it decreases the risk of an expansionist monetary policy without punishment. The transmission channel for decreasing the possibility of UFA in the economy is through the convergence between inflation and its target caused by an increase in the openness, and thus reduces the necessity of increasing primary surplus.

The results observed from the three steps in the empirical analysis for the Brazilian economy are in consonance with predictions of the theoretical model. It is important to highlight that both indices used in the analysis as proxies for openness are relevant for reducing the deviation in inflation from the target. Moreover, the failure of the CBB in the achievement of the inflation target matters for explaining increases in primary surplus. Therefore, there exists evidence that increases in openness work as a commitment technology which contributes to the success of the inflation targeting and thus reduces the risk UFA occurs.

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[10] Instruments and lags are the same as those applied in the estimation of the individual equations.

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Appendix

Table A.1

Balance of Payments - US$ (million)	
Code	***Capital account***
2845	Capital transfers (credit)
2846	Capital transfers (debit)
	Financial account
	Direct investment
8188	Brazilian direct investment (credit)
8189	Brazilian direct investment (debit)
8196	Foreign direct investment (credit)
8197	Foreign direct investment (debit)
	Portfolio investment
2874	Brazilian portfolio investment – Equity and debt securities – total (debit)
2876	Brazilian portfolio investment – foreign company equity excluding BDR (debit)
2879	Brazilian portfolio investment - Equity and debt securities – total (credit)
2881	Brazilian portfolio investment – foreign company equity excluding BDR (credit)
8215	Foreign portfolio investment (credit)
8216	Foreign portfolio investment (debit)
	Derivatives
2902	Financial derivatives – assets (net)
2903	Financial derivatives – liabilities (net)
	Other investments
2912	Other Brazilian investments – other long term assets (net)
2913	Other Brazilian investments - other short term assets (net)
2914	Other foreign investments – total (net)

Source: Central Bank of Brazil. All series were unseasoned by ARIMA-X12 process.

Table A.2

Descriptive Statistics

Variables	Mean	Median	Maximum	Minimum	Std.Dev.
PS	-2.1344	-2.2500	-0.1900	-3.0800	0.5242
$(\pi - \pi^*)$	1.5060	0.6800	12.1950	-3.4300	3.1083
(R-G)	4.7415	5.4633	16.1677	-9.5087	5.8930
D	30.5170	30.5000	41.2000	23.5000	3.0225
IR	15.9488	16.3200	26.3200	8.6500	4.2902
EX	2.2913	2.1729	3.8059	1.5914	0.5138
FOI	0.1702	0.1488	0.3980	0.0022	0.0998
CCI	62.4370	62.0000	78.0000	38.0000	8.6288

Table A.3

Unit root tests (ADF, PP, and KPSS)

Series	*ADF*			*PP*			*KPSS*			*Order*
	lag	*test*	*cv=1%*	*band*	*test*	*cv-1%*	*band*	*test*	*cv=10%*	
OS	1	-2.7323	-4.0285	2	-2.4443	-4.0280	33.5	0.1411	0.1190	I(1)
ΔPS	0	-8.4775	-4.0285	4	-8.3957	-4.0285	3.11	0.0487	0.1190	I(0)
(π - π)*	1	-3.3202	-4.0285	7	-2.8197	-4.0280	48.7	0.1286	0.1190	I(1)
Δ(π - π)*	0	-4.6976	-4.0285	1	-4.8891	-4.0285	12	0.0661	0.1190	I(0)
(R-G)	3	-4.0918	-4.0296	7	-2.8254	-4.0280	55.8	0.1729	0.1190	I(1)
Δ(R-G)	1	-5.3839	-4.0290	4	-4.9120	-4.0285	11.4	0.0411	0.1190	I(0)
D	0	-1.9824	-4.0279	4	-2.0875	-4.0280	40.5	0.1340	0.1190	I(1)
ΔD	0	-12.4400	-4.0285	3	-12.4087	-4.0285	1.89	0.0621	0.1190	I(0)
IR	1	-4.0118	-4.0285	8	-2.4358	-4.0280	74.2	0.2043	0.1190	I(1)
ΔIR	0	-3.9852	-4.0285	3	-4.3565	-4.0285	15.7	0.0615	0.1190	I(0)
EX	1	-1.9621	-4.0285	6	-2.0373	-4.0280	59.2	0.1566	0.1190	I(1)
ΔEX	0	-8.1878	-4.0285	4	-8.3167	-4.0285	4.68	0.0607	0.1190	I(0)
FOI	2	-0.6696	-4.0290	7	-0.6231	-4.0280	188	0.6984	0.1190	I(1)
ΔFOI	1	-5.2062	-4.0290	7	-9.2920	-4.0285	4.27	0.1797	0.1190	I(0)
CCI	0	-3.7063	-4.0279	6	-3.6790	-4.0280	28.1	0.0941	0.1190	I(1)
ΔCCI	0	-10.4085	-4.0285	6	-10.5132	-4.0285	2.04	0.1657	0.1190	I(0)

Note: "cv" is the critical value. Constant and linear trend were used for series. ADF – the final choice of lag was made based on Schwarz criterion. PP – spectral estimation method is Bartlett kernel and Newey-West Bandwidth is used. KPSS - spectral estimation method is Bartlett kernel and Andrews Bandwidth is used.

Table A.4

Number of Cointegrating Relations by Model

Data trend:			None	None	Linear	Linear	Quadratic
Test type:			No intercept No trend	Intercept No trend	Intercept No trend	Intercept Trend	Intercept Trend
PS, (R-G), (π - π), D*	Trace		1	1	1	1	1
	Rank or N. of CEs	0	6.3598*	6.3598*	6.5039	6.5039	6.6299
		1	6.4255	6.3921	6.4999	6.5284	6.6192
		2	6.6280	6.6105	6.6817	6.7186	6.7729
		3	6.8773	6.8768	6.9112	6.9701	6.9973
		4	7.1683	7.1991	7.1991	7.2705	7.2705
(π - π),IR, EX, D, FOI*	Trace		2	2	2	1	1
	Rank or N. of CEs	0	-0.0768*	-0.0768*	-0.0465	-0.0465	0.0938
		1	-0.0647	-0.0647	-0.0007	0.0194	0.1265
		2	0.0525	0.0677	0.1312	0.1698	0.2466
		3	0.3612	0.3449	0.3891	0.4620	0.5034
		4	0.6896	0.7094	0.7191	0.8178	0.8430
		5	1.0545	1.0762	1.0762	1.1971	1.1971
(π - π), IR, EX, D, CCI*	Trace		1	1	1	3	5
	Rank or N. of CEs	0	10.3062*	10.3062*	10.4134	10.4134	10.5635
		1	10.3554	10.3699	10.4627	10.4429	10.5600
		2	10.5179	10.5446	10.6489	10.6543	10.7351
		3	10.8152	10.8538	10.9219	10.8877	10.9521
		4	11.1720	11.1879	11.2199	11.1987	11.2270
		5	11.5393	11.5854	11.5854	11.5396	11.5396

Note: Schwarz criteria by Rank (rows) and model (columns). Lag specification for differenced endogenous is based on Schwarz and Hanna-Quinn criteria in a VAR model.

Table A.5

Johansen's Cointegration Test

	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value (0.05)	Prob.**
PS, (R-G), (π - π^*), D	R = 0*	0.2582	64.4340	54.0790	0.0045
	R ≤ 1	0.1064	24.7159	35.1928	0.4176
	R ≤ 2	0.0626	9.7466	20.2618	0.6647
	R ≤ 3	0.0086	1.1497	9.1645	0.9309
(π - π^*),IR, EX, D, FOI	R = 0*	0.3245	115.6083	76.9728	0.0000
	R ≤ 1*	0.2382	63.4308	54.0790	0.0059
	R ≤ 2	0.1195	27.2410	35.1928	0.2769
	R ≤ 3	0.0392	10.3186	20.2618	0.6085
	R ≤ 4	0.0369	5.0020	9.1645	0.2832
(π - π^*), IR, EX, D, CCI	R = 0*	0.2888	98.8343	76.9728	0.0004
	R ≤ 1	0.2053	53.5124	54.0790	0.0561
	R ≤ 2	0.0909	22.9516	35.1928	0.5316
	R ≤ 3	0.0679	10.2813	20.2618	0.6122
	R ≤ 4	0.0070	0.9280	9.1645	0.9603

Note: (*) denotes rejection of H_0 at the 5% significance level. (**) MacKinnon-Haug-Michelis (1999) p-values.